

5 We claim:

1. A method for operating a water softener having a resin bed and a brine tank, said water softener being connected to a source of water, to provide a first mode of operation wherein a first salt type is used for regeneration and a second mode of operation wherein a second salt type is used for regeneration, the method comprising the steps of:

- a. selecting a salt type;
- b. adding a quantity of salt to the brine tank; the salt being of the selected salt type;
- c. adding a first quantity of water to the brine tank if said selected salt type is the first salt type, said first quantity of water being determined by the solubility of said selected salt type, whereby the water forms a brine of a desired concentration;
- d. adding a second quantity of water to the brine tank if said selected salt type is the second salt type, said second quantity of water being in addition to the first quantity of water and being determined by the solubility of said second salt type, said second quantity of water forming a brine of the desired concentration; and
- e. exposing the resin bed to said brine to regenerate the resin bed.

2. The method of claim 1, wherein the desired concentration is a saturated brine with a predetermined quantity of the selected salt in solution.

- 5            3.     The method of claim 1, wherein said first salt type is sodium chloride and said  
                 second salt type is potassium chloride.
4.     The method of claim 1, wherein said second quantity of water is about twenty-  
                 five percent of said first quantity of water.
5.     The method of claim 1, further comprising the steps of:
- 10           a.     determining the temperature of the brine; and
- b.     calculating said second quantity of water based on said temperature.
6.     The method of claim 5, wherein said second salt type is potassium chloride.
7.     The method of claim 1, further comprising the steps of:
- a.     measuring the water temperature of the source water; and
- 15           b.     calculating said second quantity of water based on said water temperature.
8.     The method of claim 7, wherein said second salt type is potassium chloride.
9.     The method of claim 1, further comprising the steps of:
- a.     measuring the temperature of said brine; and
- b.     calculating said second quantity of water based on said temperature.
- 20           10.    The method of claim 9, wherein said second salt type is potassium chloride.
11.    A method for regenerating a water softener, having a resin bed and a brine tank,  
                 comprising the steps of:
- a.     commencing a flow of water into the brine tank, said brine tank containing  
                 a quantity of a regenerant salt, whereby regenerant salt dissolves to form a
- 25           brine;
- b.     measuring the temperature of said brine;

- 5
- c. calculating a theoretical water quantity necessary to dissolve a predetermined quantity of the regenerant salt based on said temperature;
  - d. maintaining and measuring said flow of water until the measured quantity of water in the brine tank equals the theoretical water quantity; and
  - e. exposing the resin bed to said brine to regenerate the resin bed.
- 10 12. The method of claim 11, further comprising the steps of:
- a. measuring the temperature of said brine at regular intervals of time;
  - b. re-calculating a theoretical water quantity based on the most recently measured brine temperature and the regenerant salt selected; and
  - c. maintaining said flow of water so that the measured quantity of water is at
- 15 least as great as the most recently re-calculated theoretical quantity of water.
13. A water softener connected to a source of water, comprising:
- a. a brine tank;
  - b. a resin tank;
- 20
- c. a resin bed disposed in said resin tank;
  - d. a piping system connecting said brine tank to said resin tank;
  - e. salt selection means for selecting a salt type from a plurality of salt types;
  - f. water quantity means for calculating and measuring a quantity of water based on said selected salt type; and
- 25
- g. means for connecting said brine tank to the source of water,

- 5                   h.       whereby said brine tank is filled with said quantity of water to form a  
brine, and said brine may be transferred through said piping system to said  
resin tank to regenerate said resin bed.
14.   The water softener claimed in claim 13 including
- 10           a.       a temperature sensor disposed in said brine tank for measuring the  
temperature of the brine therein;
- b.       said water quantity means includes means for calculating a theoretical fill  
time based on said temperature; and
- c.       means for filling said brine tank with water for an amount of time at least  
as great as said theoretical fill time.
- 15           15.   A water softener, comprising:
- a.       a resin tank;
- b.       a resin bed disposed in said resin tank;
- c.       a brine tank for preparing a salt solution for regenerating the resin bed;
- d.       a piping system connecting said brine tank to said resin tank;
- 20           e.       salt selection means for selecting a regenerative salt type from a plurality  
of salt types;
- f.       water dispensing means for measuring and placing either a first quantity of  
water in the brine tank when a first salt type is selected or a second  
quantity of water in the brine tank when a second salt type is selected, said  
25           second quantity of water being greater than the first quantity of water; said  
water interacting with a salt in the brine tank to form a brine;

- 5 g. means for connecting said brine tank to a source of water;
- h. brine draw means for withdrawing brine from the brine tank and running  
the brine to the resin tank and through the resin bed, whereby the resin bed  
is washed with a first quantity of brine having a volume substantially  
equal to the first quantity of water if the first salt type is selected and a  
10 second quantity of brine having a volume substantially equal to the second  
quantity of water if the second salt type is selected.
16. In a water softener having a resin tank, a resin bed disposed in the resin tank, a  
brine tank intended to contain a salt for regenerating the resin bed, the  
improvement comprising: a brine feed-water selection means for selecting either a  
15 predetermined first quantity of water or a variable second quantity of water, either  
of said quantities to be added to the brine tank during regeneration, the first water  
quantity being associated with a first salt type, the second water quantity being  
associated with a second salt type, the second water quantity being greater than  
the first water quantity.
- 20 17. The water softener of Claim 16 wherein the second water quantity is between  
10.2% and 27.2% greater than the first water quantity.
18. The water softener of Claim 16 wherein the second water quantity is about 25%  
greater than the first water quantity.
19. The water softener of Claim 15 and including a temperature sensing means for  
25 determining the temperature of the brine, and wherein the water dispensing means  
adjusts the quantity of water for the second water quantity whereby it is

- 5 substantially equal to  $2Q=1Q+1QRT$ , wherein  $2Q$  equals the second water quantity and  $1Q$  equals the first water quantity and  $R$  equals an adjustment rate per degree Fahrenheit of the brine below 80 degrees Fahrenheit and  $T$  equals the temperature of the brine in degrees Fahrenheit, and the adjustment rate is in the range of 0.0054 to 0.0058.
- 10 20. In a water softener having a resin tank, a resin bed disposed in the resin tank, and a brine tank for preparing a brine for regenerating the resin bed, the improvement comprising:
- 15 a. a brine feed-water means for filling the brine tank with water to prepare a brine;
- b. a temperature sensing means for determining the temperature of the brine; and
- c. adjustment means coupled with the feed-water means and the temperature sensing means for changing the quantity of water fed into the brine tank in accordance with the temperature sensed by the temperature sensing means.
- 20 21. The water softener of Claim 20 wherein the adjustment means adjusts the water quantity at a rate substantially equal to  $-0.0029$  times the temperature sensed.
22. The water softener of Claim 20 wherein the brine feed-water adjustment means adjusts the water quantity substantially in accordance with  $-0.0077$  times the temperature sensed.
- 25 23. The water softener of Claim 20 including a salt selection means, the salt selection means being coupled with the adjustment means, wherein the adjustment means

- 5 adjusts the water quantity at a rate per degree change in the temperature sensed,  
said rate being substantially in accordance with (the solubility quotient -1) divided  
by 40, wherein the solubility quotient equals the solubility at 80° F of the salt  
selected divided by the solubility at 40°F of the salt selected.
- 10 24. A method for regenerating a water softener having a resin bed and a brine tank,  
said water softener being connected to a source of water, the method comprising  
the steps of:
- a. selecting a salt type from the group consisting of sodium chloride and  
potassium chloride;
  - b. adding to the brine tank a quantity of salt of said selected salt type;
  - 15 c. adding to the brine tank a first quantity of water to form a brine, said first  
quantity of water being determined by the amount of salt desired for  
regeneration at a standard solubility;
  - d. determining the solubility of the salt in the brine;
  - e. adding to the brine tank an additional quantity of water if the solubility of  
20 the brine is determined to be different than the standard solubility; and
  - f. exposing the resin bed to said brine to regenerate the resin bed.
- 25 25. The method of claim 24, wherein said standard solubility is about 2.99 pounds per  
gallon and said additional quantity of water is at least 16 percent of the first  
quantity of water.
26. The method of claim 25, wherein said additional quantity of water is about  
twenty-five percent of said first quantity of water.

- 5           27.    The method of claim 24, wherein said standard solubility is about 2.99 pounds per gallon and further comprising the steps of:
- a.       selecting a temperature parameter; and
  - b.       calculating said additional water quantity as being substantially equal to  $(6.91 - [.029 \text{ brine temperature}])10^{-1} (80 - \text{brine temperature})$  as a percent.
- 10          28.    The method of claim 24, further comprising the steps of:
- a.       measuring the temperature of the source water; and
  - b.       calculating said additional water quantity as being substantially equal to  $(74.9 + .0029 \text{ times the water source temperature raised to the second power} - 1.309 \text{ times the water source temperature})$  as a percent.
- 15          29.    The method of claim 24, further comprising the steps of:
- a.       determining the temperature of said brine; and
  - b.       calculating said additional water quantity as being a function of (the amount of salt desired in the brine  $\div$  solubility of the salt at 80°F)  $([\text{solubility of the salt at } 80^\circ\text{F} \div \text{solubility of the salt at said temperature determined}] - 1)$ .
- 20          30.    The method of claim 24, wherein the regenerant salt is potassium chloride and further comprising the steps of:
- a.       measuring the temperature of the brine; and
  - b.       calculating said additional water quantity as being substantially equal to  $(6.91 - [.029 \text{ brine temperature}])10^{-1} (80 - \text{brine temperature})$  as a percent.
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5           31.    A method for regenerating a water softener with a salt having a solubility which varies in accordance with the temperature of the brine, the water softener having a resin bed and a brine tank and being connected to a source of water, the method comprising the steps of

- 10           a.       adding the salt to the brine tank;
- b.       determining the quantity of salt desired for regeneration;
- c.       adding a first quantity of water to the brine tank to form a brine, said first quantity of water being approximately equal to a theoretical amount as if the brine were at room temperature, said theoretical amount being said quantity of salt desired for regeneration divided by the solubility of the salt
- 15                 at room temperature;
- d.       determining the temperature of the brine;
- e.       determining the solubility of the brine at the temperature determined;
- f.       adding an additional quantity of water to the brine tank, said additional quantity being determined as a function of the solubility of the salt at the
- 20                 temperature determined; and
- g.       exposing the resin bed to said brine to regenerate the resin bed.

             32.    The method of claim 31 wherein the function is substantially equal to the solubility difference divided by the solubility product, the solubility difference being determined by subtracting the solubility at the determined temperature from the solubility at room temperature, the solubility product being determined by multiplying the two solubilities.

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- 5            33.    The method of claim 31 wherein said additional quantity is substantially equal to  
(the amount of salt desired for regeneration  $\div$  the solubility of the salt at the  
temperature determined) minus (the amount of salt desired for regeneration  $\div$   
solubility of the salt at room temperature).